Computer Networking Illuminated

Chapter 3

Network Technologies

Introduction

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Introduction

- Understanding networking technologies begins by understanding the terminology used

- Modern computer networks can be classified into one of three broad categories centering on the connection and geographic configuration strategy used with the physical devices

Defining Network Terms

- A Local Area Network (LAN) is a collection of networking equipment located geographically close together
- A LAN is owned by the same company
- A LAN utilizes high-speed data transfer capabilities

Defining Network Terms

- A Wide Area Network (WAN) is a collection of networking equipment geographically separated

- Connection services, and possibly equipment, are leased from telecommunications providers such as phone companies or ISPs

- Equipment runs at much slower speeds compared to LANs

Defining Network Terms

- A Metropolitan Area Network (MAN) combines the characteristics of both LANs and WANs

- A MAN is limited by geography to a single metropolitan area

- Local Access and Transport Areas (LATAs) are often used to define the boundaries for MANs

Local Area Network Technology

- A Protocol is a set of rules governing a given activity

- Network protocols create standard methods of communications for networked devices

- Standard LAN protocols include Ethernet, Token Ring, and Fibre Channel

Local Area Network Technology

- The architecture of Ethernet defines how network clients gain access to the medium, or network wire at the beginning of the communications process

- Ethernet clients rely on carrier sense multiple access with collision detection (CSMA/CD)

Local Area Network Technology

- Ethernet has four frame types:
  - Ethernet I is the original Ethernet that was developed at PARC by the DIX consortium
  - Ethernet II was developed quickly after the original 802.3 specification and published in 1982

Local Area Network Technology

- Ethernet Media and Topology
    - Ethernet has evolved from a signaling rate of 10Mbps to a current speed of 1Gbps
    - current implementations utilizing 10-Gbps though this specification is not yet formally standardized

Local Area Network Technology

- Each of the following are types of physical media
    - Thick coaxial cabling
    - Thin coaxial cabling
    - Unshielded twisted pair
    - Shielded twisted pair
    - Multimode Fiber
    - Single-mode Fiber

Local Area Network Technology

- Ethernet has four frame types:
  - Ethernet SNAP (Sub-Network Access Protocol) has an additional function of to include the Type field found in Ethernet II
  - Ethernet Raw is Novell's proprietary frame format

Local Area Network Technology

- Token Ring defines a method for sending and receiving data between two network-connected devices
- To communicate in a token-passing environment, any client must wait until it receives an electronic token
- The token is a special frame that is transmitted from one device to the next

Local Area Network Technology

- There are two types of token-passing architectures:
  - Token Bus is similar to Ethernet because all clients are on a common bus and can pick up transmissions from all other stations
  - Token Ring is different from Token Bus in that the clients are set up in a true physical ring structure

Local Area Network Technology

- In Token Ring each client plugs into a device called a Multistation Access Unit (MAU), which is similar to an Ethernet hub or switch
- Each network interface has both transmit and receive ports

Local Area Network Technology

- Token Ring key components:
    - Active Monitor
    - Standby Monitor
    - Monitor contention
    - Ring polling
    - Ring purge

Local Area Network Technology

- Token Ring topologies are physically wired in a star configuration using STP or UTP (Cat4 or higher for 16 Mbps) cabling
- IBM classified its cabling by using Type instead of Category:
  - Small movable
  - Large non-movable

Local Area Network Technology

- There are three types of frames on a Token Ring network:
  - Token
  - Logical Link Control (LLC)
  - Media Access Control (MAC)

Local Area Network Technology

- Fiber Distributed Data Interface (FDDI) is another token-passing environment that relies on a dual ring configuration for fault-tolerance

- In addition to its ability to recover from a primary ring failure FDDI also functions at 100 Mbps

Local Area Network Technology

- FDDI is commonly used as a backbone network architecture because of its failover capability
- If the primary ring fails for any reason, the nearest DAC/DAS will wrap the signal on the wire

Local Area Network Technology

- Three different layouts are possible for Fibre Channel technology, as follows:
  - Point-to-point
  - Arbitrated loop
  - Fabric

Local Area Network Technology

- Point-to-point is one of the most common configurations in Fibre Channel
- It is used to connect external drive arrays, printers, and other hardware component resources to servers

Local Area Network Technology

- An arbitrated loop (AL) has become the preferred configuration for Fibre Channel

- It is a mixture of both Ethernet and Token Ring topologies

- It can support as many as 127 devices

Local Area Network Technology

- Fibre Channel configured in a fabric is used to connect as many as 16,777,216 devices in a switched configuration
- Unlike an AL configuration, the devices in a fabric can communicate at the same time
- Fibre Channel can run on fiber-optic cable and copper such as STP

Wide Area Network Technology

- WAN technologies can be traced back to the early days of mainframe computer systems
- WANs give companies the ability to leverage information technology across wide geographic areas

Wide Area Network Technology

- WANs can be classified in one of the following three ways:
  - Circuit switching involves creating a circuit between two points when needed
  - Packet switching uses virtual circuits for data delivery
  - Cell switching uses virtual circuits but the cells do not vary in size

Wide Area Network Technology

- Integrated Services Digital Network (ISDN) is a circuit-switching technology similar in function to public switched telephone network (PSTN)

- When using ISDN, you dial a number just as with PSTN but the signal is digital instead of analog

Wide Area Network Technology

- The two types of ISDN service are:
  - Basic Rate Interface (BRI) which is composed of two 64-kbps B channels and one 16-kbps D channel
  - Primary Rate Interface (PRI) which is composed of twenty-three 64-kbps channels and one 64-kbps D channel

Wide Area Network Technology

- Frame Relay is a very popular high-speed packet switching WAN protocol
- Frame Relay utilizes PVC and SVC technology for data transfer and is a subscriber-based WAN service
- A service provider connects a company into the provider's network by using Data Terminating Equipment (DTE)
- The DTE connects into the service provider's Data Communications Equipment (DCE) within the Frame Relay switching network

Wide Area Network Technology

- Switched Multimegabit Data Service (SMDS) is high-speed, cell-switching technology

- It supports data rates from DS1, at 1.544 Mbps to DS3 at 44.736 Mbps

- SMDS utilizes connectionless datagrams that are large enough to encapsulate entire LAN protocols such as Ethernet and Token Ring without altering them

Wide Area Network Technology

- Synchronous Optical Network (SONET) allows different data stream formats to be combined into a single synchronous high-speed signal over fiber
- SONET offers a common denominator signaling method for different signals by adding overhead and control information

Wide Area Network Technology

- SONET is often used in large companies with varied WAN solutions in place or between service providers
- The basic unit, or signaling rate, is 51.84 Mbps and is known as Optical Carrier 1 (OC1)
- OC-256 is the fastest current standard

Wide Area Network Technology

- High-level Data Link Control (HDLC) is commonly used on point-to-point WAN interfaces and between local serial interfaces as needed

- It is a derivative of IBM's Synchronous Data Link Control (SDLC) protocol used in Systems Network Architecture (SNA)

Wide Area Network Technology

- HDLC functions using two primary configurations:
  - Point-to-Point in which the configuration is comprised of only two nodes, one on each end of the link
  - Multipoint configurations allow the use of multiple nodes on the same link

Wide Area Network Technology

- LLC is a protocol used in Ethernet, Token Ring, and other environments such as mainframe communications
- LLC offers three types of service:
  - Type 1
  - Type 2
  - Type 3

Wide Area Network Technology

- Type 1 service is unacknowledged and connectionless
- Type 2 service is connection-oriented and provides acknowledgements for positive receipt of data during communications
- Type 3 service is connectionless but does provide acknowledgement of receipt of data

Metropolitan Area Network Technology

- MANs can use a combination of the WAN/LAN technologies for interconnecting networks
- MANs are limited in scope to a single metropolitan area or LATA
- IEEE 802.6 and IEEE 802-2001 define a wide range of characteristics of a MAN relating to technologies used

Infrastructure Protocols

- Infrastructure protocols differ from LAN and WAN protocols
- They tend to focus on extending network functionality to a small subset of users or even to a single client

Infrastructure Protocols

- Three of the most popular Infrastructure Protocols:
  - Point-to-Point Protocol (PPP)
  - Point-to-Point Tunneling Protocol (PPTP)
  - Layer 2 Tunneling Protocol (L2TP)

Infrastructure Protocols

- Point-to-Point Protocol (PPP) is used to connect client systems into an existing WAN infrastructure

- Point-to-Point Tunneling Protocol (PPTP) is most often used when connecting users using virtual private networks (VPNs)

- Layer 2 Tunneling Protocol (L2TP) is the next generation of tunneling and is similar in function to PPTP

Wireless Network Technology

- Wireless generally requires line of sight (LOS) between the two connection points

- Buildings and natural formations can cause problems when trying to send and receive signals

- Wireless offers freedom from monthly WAN fees, but the up-front cost for purchasing and installing wireless may be prohibitive

Wireless Network Technology

- Wireless can be configured using several different signaling technologies such as:
  - Radio communications involve configuring transceivers for delivering data through point-to-point or multipoint configuration over a range of 1 to 10 miles

Wireless Network Technology

- Wireless can be configured using several different signaling technologies such as:
  - Microwave technology uses microwave signaling and has the ability to be transmitted distances of 30 miles or more with significantly higher speeds
  - Infrared is a low-power wireless technology that is good for short distances, typically on an office floor

Wireless Network Technology

- Wireless technologies are currently defined in the following IEEE standards:
  - 802.11a: Operates at 5.0 GHz and has a data rate of 54 Mbps
  - 802.11b: Operates at 2.4 GHz and has a data rate of 11 Mbps
  - 802.11g: Operates at 2.4 GHz and has a data rate of 54 Mbps

Wireless Network Technology

- 802.1x uses standard Ethernet frames to encapsulate Extensible Authentication Protocol (EAP) requests

- Bluetooth is an open standard that allows interoperation between equipment from different vendors and is aimed primarily at LAN devices and components

- Home RF is one of the newest standards in RF wireless technology to help meet demands in the home networking arena